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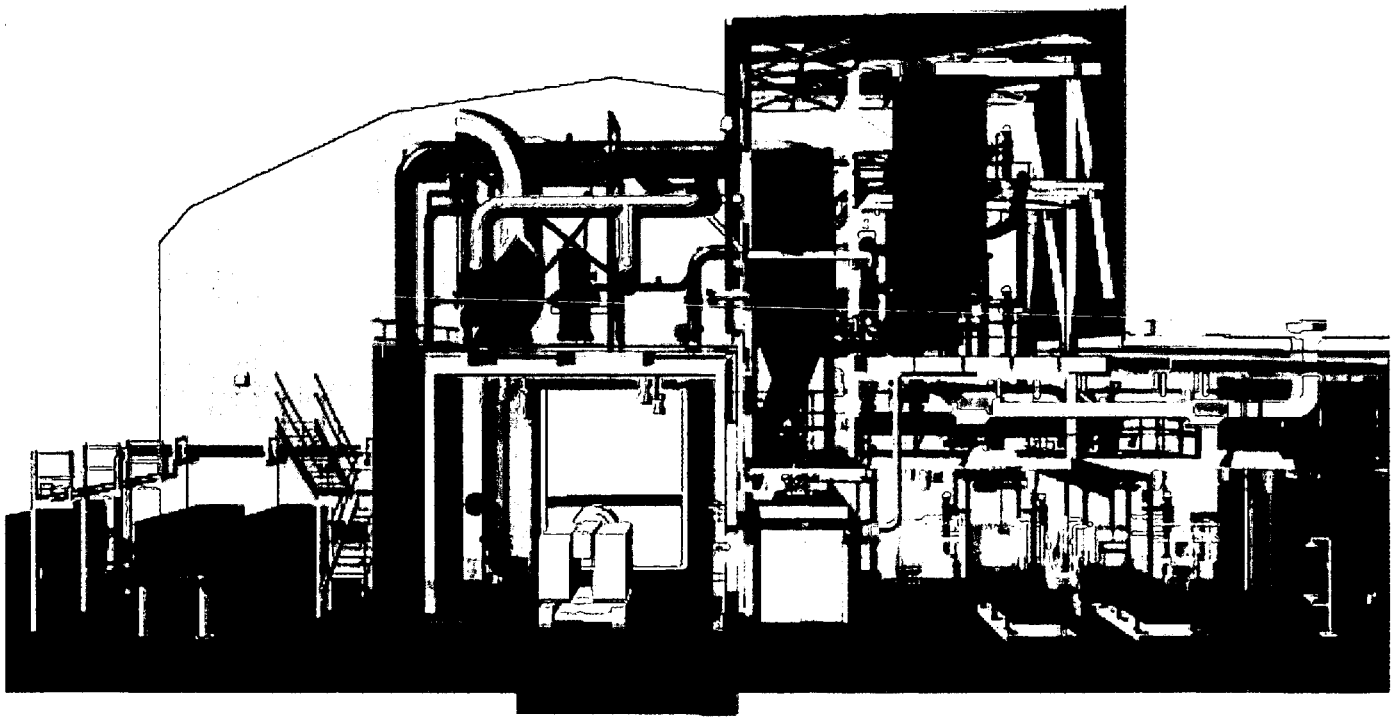
SILO 3 PROJECT

REMEDIAL DESIGN / REMEDIAL ACTION PACKAGE

40430-RDP-0001

REVISION 2

December 2003



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40430-RDP-0001
Revision 2
December 2003

SILO 3 PROJECT REMEDIAL DESIGN / REMEDIAL ACTION PACKAGE
40430-RP-0001, REVISION 1

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SILO 3 REMEDIAL DESIGN / REMEDIAL ACTION PACKAGE

INTRODUCTION

1.0 Purpose and Scope

A Remedial Design (RD) Package documenting the proposed design for retrieval, chemical stabilization, and offsite disposal of Silo 3 material was submitted to U.S. EPA and OEPA May 19, 2000, and was approved by U.S. EPA on September 27, 2000. A revised RD package was submitted to U. S. EPA and OEPA in May 2002 to document the design for the revised path forward for Silo 3 remediation. In response to the disapproval of the revised package by the U.S. EPA, the DOE, U.S. EPA, and OEPA agreed that a revised RD package would be resubmitted following approval of the Record of Decision (ROD) Amendment incorporating the necessary changes to the Silo 3 remedy. This revised package has been prepared to replace the previous RD Packages and document the design for the revised path forward for Silo 3 remediation.

The package provides a compilation of the necessary substantive information from more detailed engineering, design, and operations documentation in order to provide U.S. EPA and OEPA with an understanding of the controls incorporated into the revised design to ensure compliance with ARARs and protection of human health and the environment. The basis, prerequisites, and major components of the revised design approach are detailed in the remaining sections of this introduction.

The package also documents the scope of subsequent deliverables and appropriate milestones for implementation of the remedial action portion of the Silo 3 remedy, and thereby satisfies the requirements for a Remedial Action (RA) Work Plan for the Silo 3 Project specified by the approved Silo 3 RD Work Plan.

2.0 Background

The Silo 3 Project is a Comprehensive Environmental Response Compensation and Liability Act, as amended (CERCLA) environmental remediation (cleanup) project at the Fernald Closure Project (FCP). The objectives of the project are removal of waste material stored in Silo 3, appropriate treatment and packaging of the material, and shipment of the packaged material to an off-site disposal facility for disposal in accordance with the selected remedy for Silo 3.

Silo 3, a component of the FCP Operable Unit 4 (OU4), contains an estimated 5,088 yd^3 of byproduct material from uranium recovery operations at Fernald. The predominant radionuclide of concern identified within the material is Thorium-230, a radionuclide produced from the natural decay of Uranium-238. The material is classified as 11e.(2) by-product material under the Atomic Energy Act (AEA) of 1954, as amended, and is therefore excluded from regulation as a hazardous waste under RCRA and the associated State of Ohio hazardous waste regulations.

2.1 Silo 3 Description

Silo 3, built in 1952, is a freestanding, pre-stressed concrete, domed silo. It is 80 feet in diameter and about 33 feet above ground level. The floor system is constructed of 17 inches of compacted clay, a 2-inch thick layer of asphaltic concrete, and an 8-inch layer of gravel topped by 4 inches of concrete. Silo 3 does not have an underdrain system. The domed roof tapers from 8 inches thick at the silo walls to 4 inches thick at the apex. The apex is 36 feet high, 33 feet above grade. The walls are 27 feet high from the top of the foundation. Silo 3 contains increased reinforcing around the dome periphery (ring beam). Silo 3 has wire-wrapped pre-stressing using 8-gauge wire drawn to 0.141 inches. Five man ways on the dome of Silo 3 have an internal diameter of approximately 20 inches. One of these man ways, on which a dust collector was installed, is centered on the silo dome. Four man ways, which were used as material inlet ports, are arranged radially, 90° apart, across the dome of Silo 3. Two additional 24-inch internal diameter man ways are located on the dome, one at the northern edge and the other at the eastern edge. There are also 24 – 2-inch diameter sounding pipes and one – 6-inch diameter vent pipe on the dome. Silo 3 has a total of 46 decant ports, each with a weir and baffle system. There are 23 decant ports located on the east sidewall and 23 decant ports located on the west sidewall.

Silo 3 contains "cold" metal oxide waste generated from the operation of the feed Materials Production Center (the original name of the FCP facility). The raffinates from the solvent extraction process were dewatered using rotary vacuum filters. The filtrate wastes were then processed through evaporators and the concentrates were further processed using either a spray calciner or rotary calciner. From plant start-up through the middle 1950s, a spray calciner processed the concentrates. Approximately 35% of the Silo 3 material is believed to have come from this process. Due to operational difficulties with the spray calciners, a rotary calciner process was implemented. In this process, the evaporator concentrates were transferred to a drum dryer and finally a rotary calciner. The calciner removed residual liquids and converted the metal nitrates to metal oxides.

The resultant fine, powdered metal oxides were transferred to Silo 3, via a pneumatic pipeline, for storage. Placement of these metal oxide wastes into Silo 3 continued until 1957. After that, refinery process wastes were placed in on-site surface impoundments. About 5,088 cubic yards of metal oxide material remains in Silo 3. The predominant radionuclide of concern identified within the material is Thorium-230, a radionuclide produced from the natural decay of Uranium-238. Silo 3 material is classified as 11e.(2) byproduct material under the AEA, and contains concentrations of several heavy metals including arsenic, chromium, cadmium and selenium. Silo 3 material is exempt from regulation under RCRA, due to its classification as 11e.(2) byproduct material. The Applicable or Relevant and Appropriate Requirements (ARARs) for Operable Unit 4 apply certain requirements of RCRA to management of Silo 3 Material (see the ARAR Compliance Matrix, RD Package Section 5)

In general, based on historical information about the generation of the material, the assumed physical characteristics of the Silo 3 material are:

- Two-thirds of the Silo 3 material is dry, loose, fine powder; located in the upper portion of the silo.
- The remaining third of the Silo 3 material is compacted powder, located towards the middle and bottom of the silo.
- Miscellaneous debris (such as simple hand tools, personal protective equipment (PPE), plastic bags, etc.) may be found within the silo.
- Estimated volume of material in Silo 3 is 5,088 yd^3
- Estimated dry density of the Silo 3 material is 29 - 58 lb/ft^3

Retrieved material is expected to have a typical bulk density of about 40 – 50 lb/ft^3 prior to packaging; however, higher and lower densities may be encountered. The packaging process is expected to result in an increase in density.

3.0 Basis for Remedial Design

3.1 Silo 3 Remedy

The OU4 Record of Decision (ROD) was signed on December 7, 1994, and identified vitrification as the selected remedy for the Silo 1, 2, and 3 material. The OU4 ROD was modified for Silo 3 through the CERCLA Explanation of Significant Differences (ESD) process. The ESD for Operable Unit 4 Silo 3 Remedial Action was approved by U.S. EPA March 27, 1998. The treatment and disposal portion of the remedy for Silo 3, identified in the ESD was:

- Treatment, using either a Chemical Stabilization/Solidification or a Polymer-based Encapsulation process to stabilize characteristic metals to meet RCRA Toxicity Characteristic Leaching Procedure (TCLP) limits and attain disposal facility Waste Acceptance Criteria (WAC);
- Off-site disposal at either the Nevada Test Site (NTS) or an appropriately-permitted commercial disposal facility; and
- Treatment may take place offsite, so long as "onsite pretreatment, in combination with packaging in accordance with United States Department of Transportation (USDOT) regulations reduces the dispersability of thorium-bearing particulates to produce transportation risk less than 1 x 10^{-6}."

A Remedial Design Package, based upon the contractor design for implementation of the ESD remedy, was submitted to U.S. EPA and OEPA on May 19, 2000. The RD Package was approved by U.S. EPA on September 27, 2000.

During the process of implementing the remedy defined by the Silo 3 ESD, the path forward for remediation of Silo 3 was reevaluated, with input from U.S. EPA, OEPA, and stakeholders. In accordance with the National Oil and Hazardous Substances Pollution

Contingency Plan (NCP), a Proposed Plan (PP) and subsequent Record of Decision (ROD) Amendment was prepared to modify the Silo 3 remedy. The ROD Amendment for Operable Unit 4, Silo 3 Remedial Action was approved xx/xx/2003 and modified the treatment portion of the Silo 3 remedy to:

- Treatment to the extent practical, by addition of a chemical stabilization reagent to reduce metals mobility and a binding reagent to reduce dispersability
- If above treatment step is deemed un-implementable, a contingency backup would be implemented to double package the waste.

The remedy for Silo 3 continues to include the following components, which were not reevaluated, and remain as documented in the original OU4 ROD, and subsequent ESD for Silo 3:

- Maintain transportation risk less than $1x10^{-6}$
- Off-site disposal of Silo 3 material at the Nevada Test Site or a permitted commercial facility
- Removal of Silo 3 structure, remediation facilities, and associated systems and components; disposal of contaminated debris in accordance with the Operable unit 3 ROD.
- Cleanup of soil in Silo 3 area to meet final remediation levels in Operable Unit 5 ROD
- Appropriate treatment and disposal of all secondary wastes at the Nevada Test Site or an appropriately licensed off-site facility.
- Collection of perched water encountered during remedial activities for treatment at OU5 water treatment facilities.
- Continued access controls and maintenance and monitoring of the stored waste inventories.
- Institutional controls of the OU4 area such as deed and land-use restrictions.

3.2 Technical Basis

The path forward used as a basis for the design reflected in this RD/RA Package is:

- Pneumatic (vacuum) retrieval of Silo 3 material via silo man ways on the silo dome;
- Cutting an opening in the silo sidewall for at-grade access by mechanical equipment;
- Mechanical retrieval of Silo 3 material using remotely controlled mechanical excavation equipment (in combination with continued pneumatic retrieval as required);
- Application of a solution of lignosulfonate, water, and ferrous sulfate to the Silo 3 material as it enters the package to reduce leachability and dispersability;
- Packaging of Silo 3 material for transportation to an off-site disposal facility; and
- Transportation to the selected disposal facility(s) in accordance with DOT regulations and transportation risk criterion specified by the ROD.

The proposed design is depicted in Figure 1.

3.3 INSERT FIG 1 FROM DB&R DOCUMENT

3.3 Supporting Studies

The design documented in this RD/RA Package utilized material characterization, treatability, operability, and technical data from a wide range of studies. The primary studies supporting the technical basis of the design are summarized below.

- 1990 – 3/22/90 – IT Analytical Services – Analytical Report
- 1993 – Battelle Pacific Northwest National Laboratories (BPNNL) & FEMP – OU4 Treatability Study Report for the Vitrification of Residues from Silos 1, 2, & 3
- 1993 – FEMP – RI Report for OU4
- 1996 – Argonne National Laboratory – Silo 3 Particle Size Analysis
- 1997 – Nuclear Fuel Services – Treatability Study Report
- 1997 – Argonne National Laboratory – Silo 3 Material Compound Analysis
- 1997 – FEMP – Small-Scale Waste Retrieval (Summary info in RFP F98P132339)
- 1998 – RMRS – Treatability Testing Report (RFP F98P132339 Proposal)
- 1998 – IT Corporation – Treatability Report (RFP F98P132339 Proposal)
- 2000 – Westinghouse Savannah River Co – Characterization of Silo 3 Waste
- 2000 – RMRS – Silo 3 Characterization, Treatability, and Compaction Study
- 2001 - Westinghouse Savannah River Co – Silo 3 Physical Testing Final Report
- 2001/2002 – FEMP – Chemical Stabilization Development Work Plan
- 2001/2002 – Jenike & Johanson, Inc. – Silo 3 Material Flow Properties Test Results
- 2002 – Jenike & Johanson, Inc. – Modeling of Silo 3 Material Removal Via Vacuum Retrieval
- 2002 – Jenike & Johanson, Inc. - Silo 3 Pneumatic Retrieval Wand Loads
- 2002 – FEMP –Silo 3 Design Data Development Report
- 2002 – FEMP – Silo 3 Dedusting Report
- 2002 – Jenike & Johanson, Inc. – Pretreatment of Silo 3 Material with Lignosulfonate Solution
- 2002 - FEMP - Radon Flux Rate Measurements
- 2002 – Jenike & Johanson, Inc. – Modeling of Silo 3 Material Removal Via Mechanical Retrieval
- 2002/2003 – FEMP – Silo 3 Conditioning Report

In 1989, samples of Silo 3 material were collected during the Remedial Investigation & Feasibility Study (RI/FS), using a vibrating core-drilling instrument. Portions of the samples were analyzed by International Technologies (IT) for characterization. Of the 23 inorganic constituents detected, the predominant metals included aluminum, calcium, iron, magnesium, potassium, and sodium. Compound analyses performed by Argonne National Laboratory (ANL) on some of the archived RI/FS samples, showed that compounds in the Silo 3 material are mostly in the form of phosphates, sulfates, and oxides with the existence of some nitrates.

As presented in the 1990 IT Analytical Services report, moisture (water) content of the sampled material ranged from 3.7 to 10.2%, by weight. Also, about 90%, by weight, of the sampled material passed through a 200-mesh sieve.

The untreated RI/FS samples were analyzed for metals Extraction Procedure (EP)-Toxicity. Four metals leached above Toxicity Characteristics (TC) leaching criteria – arsenic, cadmium, chromium, and selenium. Some of the archived samples were later analyzed by Nuclear Fuel Services, Inc. (NFS) during treatability testing to establish treatment methods to stabilize the hazardous constituents of the Silo 3 material. The Toxicity Characteristics Leaching Procedure (TCLP) conducted by NFS showed that only chromium exceeded the TC leaching criteria.

In 1997, the Silo 3 Small-Scale Waste Retrieval (SSWR) activity collected samples using an auger inserted through decant ports on the west side of Silo 3. Based on data obtained during the SSWR activity, the Silo 3 material is likely compacted at the perimeter and does not flow freely up to eleven feet above the bottom of the silo. The material may be compacted throughout the bottom of Silo 3.

Subsequent treatability testing conducted by Rocky Mountain Remediation Services (RMRS) on untreated samples collected during SSWR showed that only chromium and selenium leached above the TC leaching criteria. The maximum allowable concentrations for arsenic, cadmium, chromium, and selenium are 5.0, 1.0, 5.0, and 1.0 mg/L, respectively.

In 2001 and 2002, Fluor Fernald has conducted chemical stabilization development work to develop preferred chemical formulas for stabilization of the RCRA metals and for solidification of the material into a form with minimal dusting and desirable flow characteristics.

In January 2002, a Flow Properties Test Report was issued by Jenike & Johanson, Incorporated, which presented the results of Silo 3 material characterization studies performed on available sample material. The results of this report are applicable to detailed design of the project material handling equipment and systems.

In 2002, Jenike & Johanson, Inc. modeled the behavior of Silo 3 material during removal by both mechanical and vacuum retrieval. The model used the flow properties of the material and details of the planned retrieval systems to recommend approaches to efficient and safe retrieval operation and to predict the extent of retrieval possible with the vacuum wand.

In 2002, Jenike & Johanson, Inc. issued a report analyzing the stress loads that the vacuum retrieval wand may see under different scenarios. The analysis was conducted to demonstrate that the loads that could be transmitted to the silo dome during pneumatic retrieval were within the allowable limits.

In 2002, Fluor Fernald conducted a study to develop a method to control the dispersability of Silo 3 material in order to mitigate the risk of contamination spread in the unlikely event of a transportation accident. Incorporating a certain amount of a dilute solution of sodium lignosulfonate in Silo 3 material was found to significantly reduce the fines by agglomeration.

In 2002, Jenike & Johanson, Inc. conducted a pilot plant study to evaluate the best means and process location for incorporating a dilute sodium lignosulfonate solution into Silo 3 material in order to reduce the material dust generation. The report recommended use of a spray method to be installed in the packaging container fill chute.

In 2003, Fluor Fernald issued a report covering the results of a study to develop a conditioning method for Silo 3 material that would simultaneously reduce the dusting and reduce the leachability of some heavy metals. The report indicated that treating Silo 3 material with a dilute solution of sodium lignosulfonate that had been augmented with ferrous sulfate was efficient in reducing the dusting and reducing the leachability of chromium.

4.0 Silo 3 Remedial Action Implementation

4.1 Transportation and Disposal

Immediately after each container is filled, the control system will archive the UNID (inventory number), time and date of filling, weight data, additive data, and other operational data. After the container is closed and moved to the Cargo Container Bay, pertinent radiological data will be collected via contact and one-meter dose rate surveys and archived by the control system thus completing data acquisition for that container. Once data acquisition is complete, the data set is transferred to FCP's Site-wide Waste Information Forecasting and Tracking System (SWIFTS). In SWIFTS the raw data for that container will be immediately converted through validated software to data used for determining compliance with the Silo 3, NTS waste profile as well as for DOT and NTS labeling purposes. Following verification that the waste meets the NTS profile, labels will be generated and applied to the container. These include: (1) the DOT Radioactive Label that will show the 95% radionuclide contributors, the individual package activity, and the transport index; (2) the NTS label that will show the inventory number, the profile number, and the gross weight of the container; and (3) the package certification label required by the NTSWAC. DOT labels and the NTS labels will be applied to containers on a shipment basis (8 containers). It is expected that all containers in a shipment will be labeled with their DOT and NTS labels within 24 hours of production and subsequently staged for shipment for about 1 to 2 days. The package certification label will be applied to containers not more than 24 hours before being loaded onto a trailer for shipment.

The design of the soft-sided package meets Department of Transportation (DOT) Industrial Package Type 2 (IP-2) requirements. The package has been tested and successfully passed all tests required by DOT regulations for an IP-2 package (i.e., free drop test, stacking test, and vibration test.)

According to the current design and baseline operating schedule, a total of approximately 1910 soft-sided packages will be filled at an average rate of 15 packages per day, assuming 123 days of operation at 63% availability. The current Silo 3 Project baseline assumes that the Silo 3 material will be transported by direct truck to the NTS for disposal. The current packaging and transportation approach assumes that the soft-sided

packages will be placed on pallets and loaded directly into enclosed truck trailers with the load secured in accordance with DOT regulations. The baseline assumes eight soft-sided packages will be loaded into each enclosed truck trailer, with approximately 239 total shipments over a five-month period. Each trailer should be shipped offsite less than one week after loading.

As detailed in the Revised Proposed Plan for Silo 3 (40430-RP-0014, April 2003) the Fernald site employs controls during each truck shipment to minimize the risk of an accident, and to ensure rapid response should one occur. For truck shipments to the NTS, the controls include: 1) a rigorous quality control and assurance program to ensure the quality of the packages and the conveyances and their compliance with DOT and NTS requirements; 2) affixing a global positioning system transponder to each conveyance to track the progress of each vehicle and/or ensuring that each driver has a working cellular phone or two-way radio; 3) employing screening criteria for the selection of drivers; 4) draining of drivers in the appropriate actions to be taken in response to an accident; and 5) briefing interested emergency response personnel along transportation routes.

The transportation risk evaluation conducted in support of the Revised PP for Silo 3 included evaluation of the risk to the public during both accident free and accident scenarios (including release from a damaged container) during truck transportation of Silo 3 material to the NTS. The analysis demonstrated risk within applicable guidelines for all scenarios.

Transportation and disposal of Silo 3 material will be specified in detail in the Transportation and Disposal Plan submitted in accordance with Section 4.2.

4.2 Remedial Action Deliverables

The following deliverables will be submitted according to milestones established in Section 5 to document implementation of the remedial action for Silo 3.

4.2.1 Transportation and Disposal Plan

Although the current project baseline assumes direct truck transportation to the NTS for disposal, the packaging system and other aspects of the design documented in this RD/RA Package will accommodate transportation of the Silo 3 material to the NTS and/or a permitted commercial facility by direct truck, direct rail, or combined truck/rail (intermodal) transportation. The transportation risk evaluation documented in the Proposed Plan for Silo 3 (40430-RP-0014, Revision 0, April 2003) demonstrated that any of these modes of transportation could be accomplished with a transportation risk well within the criteria specified by the ROD Amendment.

The details of the transportation and disposal operations, including onsite staging, logistics, packaging configuration and selected mode(s) of transportation to the selected disposal facility(s) will be documented in the Silo 3 Project Transportation and Disposal Plan, which will be submitted to the USEPA and OEPA for review and approval in accordance with the milestone established in Section 5.0.

4.2.2 Sampling and Analysis Plan

Previous versions of the Remedial Design Package for Silo 3 included a Sampling and Analysis Plan. The purpose of this plan was to document the sampling and analysis program to be used to demonstrate that the treated Silo 3 material met the numerical performance standards of the selected remedy for Silo 3. The ROD Amendment for Silo 3 removed the RCRA TC limits for metals as performance criteria for treatment, and requires that the material be treated, using a best management approach to meet disposal facility WAC. The ROD Amendment (Section 4,1) states, "Given the absence of any regulatory requirement, no analytical criteria (e.g., treated waste metals analyses) are necessary as part of the best management approach to demonstrate the degree of treatment." A treated waste Sampling and Analysis Plan is, therefore, no longer necessary as part of the

RD Package. The final waste acceptance process at the selected disposal facility(s) will confirm the requirements, including any necessary process control or treated waste sampling and analysis data, for demonstration that the Silo 3 material meets the disposal facility waste acceptance criteria.

4.2.3 Safe Shutdown / D&D Plan

The OU4 ROD and the ROD Amendment for Silo specify that the Silo 3 structures, and subsequently the waste retrieval and remediation facilities and equipment, will be decontaminated, dismantled, and disposed of in accordance with the OU3 ROD. The plans and schedule for decontamination and dismantlement (D&D) of the Silo 3 structures, and the facilities and equipment installed under this RD/RA Package will be documented in the D&D Implementation Plan for the OU4 Complex. In accordance with the OU3 Integrated Remedial Design/Remedial Action (RD/RA) Work Plan, as modified by letter DOE-0343-03, dated April 18, 2003, this D&D Implementation Plan is due to be submitted to the U.S. EPA for review by May 28, 2004.

5.0 REMEDIAL ACTION MILESTONES

ACTIVITY / DELIVERABLE	MILESTONE
Submit Silo 3 Remedial Action Work Plan to the U.S. EPA for review[1]	October 6, 2003 – satisfied by this submittal
Submit Silo 3 Transportation and Disposal Plan to the U.S. EPA for review	May 1, 2004
Initiate Silo 3 Remediation Facility Operations	October 1, 2004
Submit D&D Implementation Plan for the OU4 Complex to U.S. EPA for review	May 28, 2004[2]

[1]Existing milestone established by the Revised Silo 3 Remedial Design Deliverables Schedule, DOE-0724-01, 7/13/01
[2]Existing milestone established by the OU3 Integrated RD/RA Work Plan (2503-WP-0023, rev 0), May 1997, as modified by letter DOE-0343-03, 4/18/03